Post-ovulatory changes in the water content and inulin space of the rabbit oviduct

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Summary. Measurement of the water content and inulin space of the tissues of the ampulla, ampullary-isthmic junction and proximal isthmus showed that the loss of oedema was related to the position of the ova, whether this was normal (after hCG), delayed (by oestrogen treatment) or accelerated (by progesterone treatment).

Introduction

Most recent investigations into the mechanisms of regulation of oviductal ovum transport have been concerned with the propulsive forces generated by smooth muscle and cilia of the oviduct (see Harper *et al.*, 1976). Black & Asdell (1959) showed that fluid accumulates in oviducts ligated at the fimbrial end until 3 days after ovulation. They suggested that oedema of the proximal isthmus and the uterotubal junction region could account for the apparent block of fluid flow into the uterus, but were unable to demonstrate oedema histologically and found that ovum transport was unaffected by administration of diuretic agents. Andersen (1928) had previously suggested, on the basis of histological studies, that oedema of the pig uterotubal junction occurs until the 4th day after ovulation. Similar histological studies and conclusions were reported by Edgar & Asdell (1960) for the ewe. Therefore, although oedema of the oviduct and/or uterotubal junction has been suggested to play a role in the regulation of the timing of ovum transport, there is no direct, quantitative evidence to support this postulate. The present study was designed to determine the water content and extracellular space of rabbit oviducts removed after ovulation or after treatments with oestrogen and progesterone known to alter ovum transport.

Materials and Methods

After isolation in a constant environment for at least 30 days, 46 sexually mature New Zealand White virgin does (3.5–4 kg) were divided into 5 groups. Animals in Group I were killed at oestrus, determined from the moist and pink appearance of the vulva (ova were not present in the oviducts of this group); those in the other groups each received an ovulation-inducing intravenous injection of 100 i.u. hCG (A.P.L., Ayerst, New York) at 0 h. The does in Groups II and III were killed 24 and 72 h respectively after the hCG injection. The Group IV does were given an intramuscular injection of 2.5 mg progesterone (Proluton: Schering Corp.) at –48, –24 and 0 h and were killed at +24 h. Group V animals were injected with 250 µg oestradiol-17β cyclopentylpropionate (Depo Estradiol: Upjohn Co.) at 0 h and were killed 72 h after hCG.

All animals were killed with an overdose of sodium pentobarbital. The oviducts were rapidly excised, trimmed of fat and accessory membranes and the length measured. Segments were taken from the oviduct at positions 20–40, 50–60 and 80–90% from the fimbrial end and were considered to represent the ampulla, the ampullary-isthmic junction and the proximal isthmus, respectively.

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Tissues were dissected in Tyrode's solution (about 10 min) at 37°C and were cut open longitudinally. To measure water content, tissues were lightly blotted, weighed and dried for 18 h (to constant weight) at 95°C and reweighed.

For inulin space measurements, tissues were placed on hooks and were equilibrated for 30 min in Tyrode's solution at 37°C. They were then incubated in Tyrode's solution containing 0.01 µCi [¹⁴C]carboxyl inulin/ml at 37°C for 60 min as described by Goodford (1968) and Paton (1975). The tissues were then rinsed rapidly in Tyrode's solution to remove surface radioactivity, blotted lightly, weighed and digested in tissue solubilizer (Protosol: New England Nuclear). After addition of scintillation fluid radioactivity was counted with a beta scintillation spectrometer. Aliquots of the incubation medium were also counted. Correction for quenching was made by using the channels-ratio method. Inulin space was calculated by dividing counts/min per kg tissue wet weight (c.p.m./kg) by counts/min per ml incubation medium (c.p.m./ml).

Results

These are shown in Table 1. The water content of oviducts from oestrous animals (Group I) and those in Groups II and V did not differ in any segment, but was significantly reduced in all oviduct segments of progesterone-treated animals and the ampullary-isthmic junction and proximal isthmus of animals killed 72 h after hCG. The inulin space of the ampulla was less than that of the other two segments. There were no differences between treatment groups for inulin space of the ampulla or ampullary-isthmic junction, but in the isthmic segments the inulin space in Group III animals was higher than that in the other treatment groups.

Table 1. Water content and inulin space of ampulla, ampullary-isthmic junction and isthmus of the oviducts of rabbits killed at oestrus (Group I), 24 or 72 h after hCG (Groups II and III), 24 h after hCG and treated with progesterone (Group IV), and 72 h after hCG and treated with oestradiol (Group V)

Group	Ampulla		Ampullary-isthmic junction		Proximal isthmus	
	H ₂ O (ml/kg)	Inulin space (ml/kg)	H ₂ O (ml/kg)	Inulin space (ml/kg)	H ₂ O (ml/kg)	Inulin space (ml/kg)
I	805 ± 5 ^a (16)†	283 ± 13 ^a (6)	808 ± 8 ^{ab} (8)	348 ± 21 ^a (6)	790 ± 7 ^{ab} (16)	348 ± 11 ^b (12)
II	797 ± 3 ^a (28)	288 ± 15 ^a (6)	809 ± 3 ^a (14)	306 ± 16 ^a (6)	795 ± 3 ^a (28)	324 ± 7 ^b (12)
III	791 ± 4 ^a (28)	324 ± 26 ^a (6)	791 ± 5 ^{bc} (14)	377 ± 21 ^a (6)	781 ± 5 ^b (28)	382 ± 8 ^a (12)
IV	769 ± 5 ^b (28)	284 ± 20 ^a (6)	783 ± 3 ^c (14)	354 ± 7 ^a (6)	773 ± 4 ^b (28)	347 ± 9 ^b (12)
V	791 ± 3 ^a (24)	291 ± 16 ^a (6)	805 ± 3 ^a (12)	334 ± 23 ^a (6)	795 ± 4 ^a (24)	330 ± 10 ^b (12)

† Values are mean ± s.e.m., number of samples in parentheses. Within each column, values with similar superscripts are not significantly different ($P > 0.05$, Student-Neuman-Kuels procedure) (Sokal & Rohlf, 1969).

Discussion

The present data provide direct evidence in support of the contention that loss of oedema of the oviduct occurs during ovum transport. At 24 h after hCG, ova are at the ampullary-isthmic junction or are entering the isthmus, whereas by 72 h ova are entering or have entered the uterus. At 24 h after hCG, ova in progesterone-treated animals have entered the uterus whereas by 72 h ova are still at the ampullary-isthmic junction in oestrogen-treated does (Pauerstein, Anderson, Chatkoff & Hodgson, 1974). Entry of ova into the uterus is therefore associated with loss of tissue water. Although the present data do not distinguish between water content of smooth muscle and mucosal layers, decreased water content may result in an increase in luminal diameter and decreased resistance to movement of

fluid and ova through the isthmus or uterotubal junction. In the isthmus at 72 h after hCG, there is an increase in extracellular space, suggesting that there is a decrease in cell volume, and supports the electron microscope findings of an increase in extracellular space between the muscle cells of the isthmus at 68 h after hCG treatment (Seki, Rawson & Hodgson, 1978).

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